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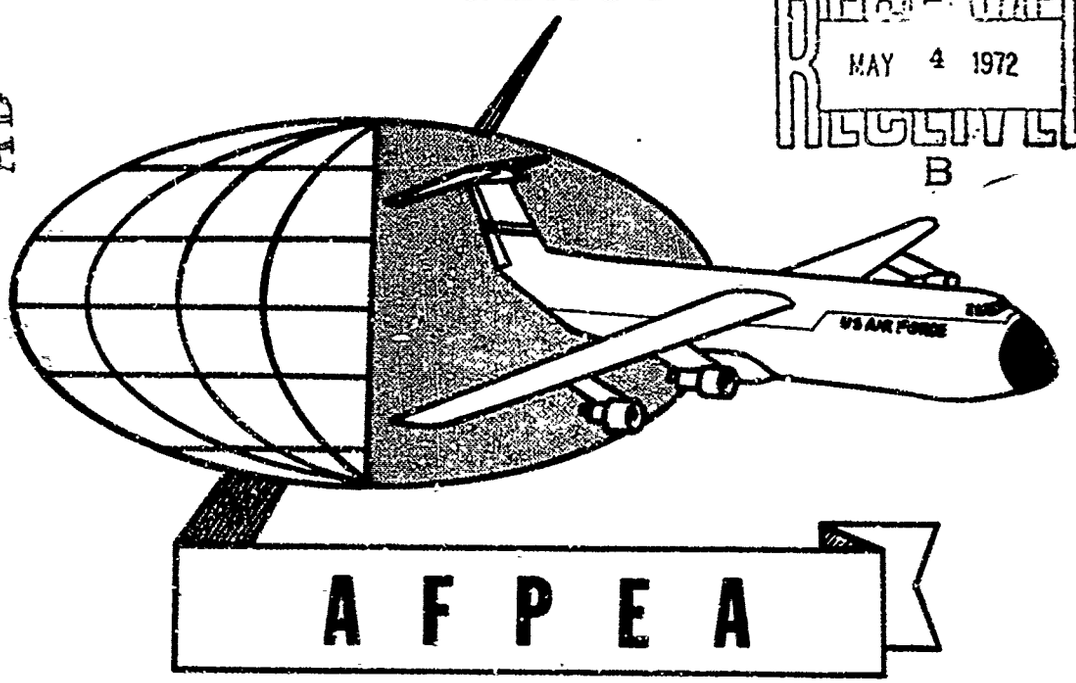

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EVALUATION OF MIL-I-26860

HUMIDITY INDICATORS

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13. ABSTRACT

A series of tests intended to determine the reliability of humidity indicators procured under MIL-I-26860, Indicator, Humidity, Plug, Color Change, and taken from service at the Military Aircraft Storage and Disposition Center were conducted. The specimens tested did comply with the requirements of MIL-I-26860; however, the performance of the indicators was erratic.

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Table of Contents

INTRODUCTION:

The basic objective of this project was to determine the reliability of plug type humidity indicators procured under MIL-I-26860 and taken from extended service at the Military Aircraft Storage and Disposition Center (MASDC), Davis-Monthan AFB, Arizona.

BACKGROUND:

The storage procedures employed at MASDC for the preservation of aircraft are being reviewed in hopes of standardizing Air Force, Navy, and Army requirements and improving the degree of protection offered. Preliminary meetings on a tri-service basis held in January 1972 indicated some concern for the reliability of MIL-I-26860 humidity indicators. As a result, this Directorate in conjunction with the 4950th Test Wing/LGF was tasked with conducting preliminary studies on indicator reliability.

Description of Test Specimens:

All humidity indicators were received from MASDC. Specimens 1, 2, and 3 were new indicators and were never placed in service. Specimens 4 through 8 were taken from service. All specimens were identified as follows:

Specimen No:	Identification:
1	New condition--manufactured by Driaire, Inc., Norwalk, Connecticut, Model # 352.
2	Same
3	Same
4	Used condition--manufactured by Driaire, Inc., Model # 352. MASDC identification: P-2,131435 #2 Jet Tail Pipe.

Specimen No:	Identification:
5	Used condition--manufactured by Driaire, Inc., Model # 352. MASDC identification: T-33B, 138061--aircraft facing north.
6	Used condition--manufacturer unknown. Model #2156. MASDC identification: F8A 143695, intake, aircraft facing north.
7	Used condition--manufacturer unknown. Model #2156. MASDC identification: F-8A, 145370, intake,aircraft facing south.
8	Used condition--manufactured by Driaire, Inc., Model #352. MASDC identification: T-33 139013, intake,aircraft facing south.

Test Equipment:

A humidity cabinet, model FR 256 PCX, manufactured by the Blue M Company, was used to expose the indicators to various environmental conditions. This unit can control temperatures to within $\pm$ 2°F and can control relative humidity to within $\pm$ 1/2%.

Test Procedure:

The humidity cabinet was adjusted to the specific temperature and relative humidity under question and allowed to stablize. When a change in temperature and humidity settings was required, the indicators were allowed to remain in the chamber during the transition period.

The following sequence of conditioning was followed:

Condition A - 72°F, 30% RH for 24 hours.

Condition B - 74°F, 33% RH for 16 hours.

Condition C - 75°F, 40% RH for 24 hours.

Condition D - 70°F, 48% RH for 3 hours.

Condition E - 71°F, 45% RH for 2 hours.

Condition F - 71°F, 37% RH for 3 hours.

Condition G - 73°F, 50% RH for 48 hours.

RESULTS:

The visual observations recorded during each of the seven conditioning periods are shown in Table I.

DISCUSSION:

From the data presented in Table I, it is apparent that the first seven humidity indicators tested do meet the color sensitivity requirements of MIL-I-26860. It should be noted that specimen number 8 was consistent in indicating dual relative humidity conditions. No explanation can be offered for this beyond the possibility of a defect in manufacture. The "white" indication of specimens 3 and 4 after 48 hours at 73°F and 50% RH is interpreted and may, to other observers, appear light blue or pink. Color sensitivity and individual interpretation of color are the primary drawbacks to this type of humidity indicator. This Directorate has recognized this problem for some time and is now in the process of developing, through a contract effort, a more reliable indicator system. A brief summary of what is expected to be accomplished is contained in the Statement of Work now being processed through procurement. A copy of this Statement of Work is enclosed as attachment 1.

CONCLUSIONS/RECOMMENDATIONS:

Based on the results of the evaluation, all specimens with the exception of number 8 are considered to meet the minimum basic color sensitivity requirements of the procurement specification.

It is felt that further indicator evaluations at this time would only duplicate the results of this report and what is being experienced by other field activities. Successful completion of the contract program outlined in attachment 1 will alleviate the problem. As an interim measure, it is recommended that the color sensitivity requirements of MIL-I-26860 be tightened to insure a distinct color change at the 75°F and 40% RH point.

7

TABLE I - Test Results

SPECIMEN NO.	CONDITION A 72°F-30% RH	CONDITION B 74°F-33% RH	CONDITION C 75°F-40% RH	CONDITION D 70°F-48% RH	CONDITION E 71°F-45% RH	CONDITION F 71°F-37% RH	CONDITION G 73°F-50% RH
1	Blue	Blue	Blue	Pink	Pink	Blue	Blue
2	Blue	Blue	Blue	Pink	Pink	Blue	Pink
3	Blue	Blue	Blue	Pink	Pink	Blue	White
4	Blue	Blue	Blue	Pink	Pink	Blue	White
5	Blue	Blue	Blue	Pink	Pink	Blue	50% Blue 50% Pink
6	Blue	Blue	Blue	Pink	Pink	Blue	Pink
7	Blue	Blue	Blue	Pink	Pink	Blue	Pink
8	30% Pink 70% Blue	30% Pink 70% Blue	30% Pink 70% Blue	Pink	Pink	Pink	50% Blue 50% Pink
Specification Requirement	Blue	Blue	Pink*	Pink	Pink	Blue	Pink

Note: Observations are at end of test period.

*Under exact conditions of 75°F and 40% RH, indicators should be pink; however, tolerances on humidity cabinet are not such as to insure exactly 75°F and 40% RH.

HUMIDITY INDICATOR IMPROVEMENT

STATEMENT OF WORK

1.0 INTRODUCTION.

1.1 This work statement establishes the requirement for a contractual effort to investigate the characteristics of all available humidity indicators and to relate these characteristics to the requirements for the protection of contents of packages/containers from moisture damage. Also, to modify existing and/or develop, if required, new humidity indicating mediums and/or devices that are not dependent on color code change and can preferably be read without opening the package/container or require the use of inspection windows. Based on the results of this program, to develop packaging requirements and recommendations for the use of humidity indicators.

The humidity indicator(s) shall be adaptable for all sizes and shapes of packages/containers. Cost effectiveness of the system shall enable the production of either a few or a large quantity of the humidity indicators.

New concepts which would enable the achievement of these goals are encouraged.

2.0 SCOPE.

2.1 This contract provides for a program to modify an existing or to develop new humidity indicator(s) that shall not be dependent on color code change and can be evaluated preferably without opening the package/container or require the use of an inspection window. The contractor shall demonstrate that the humidity indicator(s) shall be able to meet the packaging criteria on which this work statement is based.

2.2 The primary objective of this contractual program is to identify and develop design criteria for the manufacture of humidity indicator(s) that can be produced in a cost effective manner for use in the monitoring of moisture content in the packaging/containerization of military items.

2.3 The contract shall consist of three one-time tasks each interrelated with the other to achieve the following major objectives:

a. To modify, develop, or select material(s) that shall be used in the manufacture of humidity indicator(s).

b. To conduct the design and to establish criteria for the manufacture of prototype humidity indicator(s).

c. To manufacture and submit prototype humidity indicator(s) for the evaluation by the Air Force to confirm their effectiveness and reliability and the contractor shall also conduct a test of the humidity indicator(s) in packages/containers demonstrating the feasibility of the design and its effectiveness to the satisfaction of the Air Force.

3.0 BACKGROUND.

3.1 One of the primary causes of damage to packaged items is corrosion. When the moisture content within a package/container exceeds a given level (which will vary depending on the item that is being protected), rust, mildew, rot, etc, will begin to form and the product will be ruined or its value will be considerably reduced.

Humidity indicators are items used to detect and measure the amount of moisture content within a package/container.

Card humidity indicators (used by the Air Force) have been manufactured based on the color change of cobaltous chloride or a similar chemical. These humidity indicators are easily damaged by excessive moisture, are difficult to read accurately, and require the opening of the package/container in many cases to determine the actual condition within the package/container or require the use of a window for inspection.

The plug type humidity indicator is cumbersome to use and has the same deficiencies as the card type.

There is a great need for an improved or an entirely new concept of humidity indicators.

3.2 Applicable Documents.

3.2.1 The following documents, together with the amendments and revisions in effect on the date of this Statement of Work, shall form a part of this work statement and shall be applicable where appropriate. Copies of documents required shall be obtained from or as directed by the contracting officer:

a. MIL-D-3464 - Desiccants (Activated) in Bags; For Static Dehumidification and Packaging.

b. MIL-D-3716 - Desiccants (Activated) For Dynamic Dehumidification.

c. MIL-I-6131 - Indicator, Humidity Plug.

d. MIL-I-8835 - Indicator, Humidity Card, Chemically Impregnated.

e. MIL-I-26860 - Indicator, Humidity, Plug, Color Change.

f. MIL-P-116 - Preservation, Methods Of.

g. MIL-P-9024 - Packaging, Materials Handling, and Transportability System and System Segments, General Specification For.

h. MS-20003 - Indicator - Humidity, Card, Three-Spot Impregnated Area.

i. MS-26507 - Indicator, Card, Desiccant Relative Humidity (8% ± 5%).

j. MIL-STD-810 - Military Standard Environmental Test Methods For Aerospace and Ground Equipment.

k. Federal Test Method 101 - Preservation, Packaging, and Packing Materials: Test Procedures.

4.0 TASKS.

4.1 Task I - Investigation.

4.1.1 The contractor shall obtain for this test and evaluation all known card, mechanical, and electronic humidity indicators or any combination thereof which are available on the open market.

4.1.2 The contractor shall monitor installed humidity indicators in packages/containers and present the data on accuracy, reliability, and effectiveness. The humidity indicators shall be those obtained in accordance with 4.1.1.

4.1.3 The contractor shall obtain data on the advantages and/or disadvantages of reading and/or replacement of humidity indicators in packages/containers.

4.1.4 The contractor shall, upon test and evaluation of the humidity indicators presently used, submit justification, and based on engineering data a determination as to modification of existing or the development of a new humidity indicating medium and/or device.

4.1.5 At the end of Task I, the contractor shall submit a report summarizing the results of Task I. At the time of submission of the report of Task I, approaches to be considered in Task II should also be presented.

4.2 Task II - Design and Manufacture of Prototype Humidity Indicator(s).

4.2.1 The contractor shall design and manufacture humidity indicator(s) of the required characteristics based on the data developed from Task I.

4.2.2 The humidity indicator(s) may be designed using chemical, mechanical, electronic, materials, or any combination of these devices. However, the design shall not be dependent on color code change.

4.2.3 The contractor shall develop, refine the design, and manufacture the humidity indicator(s) from materials improved by the state of the art when feasible. Design materials are to remain relatively stable at temperatures from -65°F to +140°F with a 75% R.H.

4.2.4 The contractor shall design humidity indicator(s) to be operationally unaffected by shock and vibration and shall be accurate to a plus or minus temperature reading of 3°F and a plus or minus 5% relative humidity from -20°F to +120°F with a relative humidity range from 35% to 65%.

4.2.5 The humidity indicator(s) shall be compact, economical, and shall be easily installed in a package/container as determined by the Air Force.

4.2.6 As a design objective, the humidity indicator shall not exceed a displacement of not more than eight cubic inches.

4.2.7 Once the design, material, and the manufacturing criteria are defined, they shall be reported through the procuring activity. At this time, the selection of materials and the manufacturing techniques for Task III shall be defined. Start of Task III must await approval by the Air Force of the recommended approach. The decision for approval shall not be delayed more than ten working days after the report is received by the project engineer.

4.2.8 The cost objective for this item shall not exceed $5.00.

4.2.9 At the end of Task II, the contractor shall submit a report summarizing the results of Task I and Task II and shall report the recommendations for development of Task III along with a test program to be approved by the Air Force.

4.3 Task III - Manufacturing of Prototype Items.

4.3.1 Upon approval by the Air Force of the selected materials, design, tooling, and manufacturing techniques, ten each prototype(s) of the final end item(s) shall be manufactured and submitted to the Air Force Packaging Evaluation Agency for testing and evaluation.

4.3.2 The following characteristics shall be considered as essential in the manufacturing of the prototype humidity indicator(s).

a. Ability to function in any climatic condition and in the normal Air Force distribution system.

b. Cost effectiveness including materials and fabrication.

c. Overall performance as outlined in this Statement Of Work.

4.3.3 The contractor shall perform the necessary analysis and test to predict and verify the necessary reliability as established in Task I and Task II.

4.3.4 Cost studies on the prototype humidity indicator(s) shall be conducted by the contractor and included in the final report for the manufacture of quantities of 1, 100, 1000, 5000, and 10,000.

5.0 REPORTS.

5.1 Status Report. For each task, the contractor shall submit, at the end of each quarter, a status report with any applicable attachments pertaining thereto. The report at the conclusion of Task I and Task II shall be considered as a report for the respective quarter.

5.2 Final Report. Within 30 days after completion of the work contained herein, the contractor shall submit a complete final report summarizing all the findings, notes, data, engineering, drawings, and conclusions of the total work performed under this Statement Of Work.

5.3 The final report shall be approved by the Air Force Packaging Evaluation Agency before final printing.

5.4 The contractor shall submit 50 copies of the final report to the Air Force Packaging Evaluation Agency.

6.0 CONTRACT END ITEM.

6.1 The contractor shall submit along with the final report as required in 5.2 and prototype indicator(s) as required in 4.3.1, a quantity of 500 each humidity indicator(s) as developed under this Statement Of Work for the purpose of testing and evaluation.

9

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